Fall 12-9-2021

Daily Anesthesia Apparatus Checkout: Objective Structured Clinical Exam (OSCE) for First Year Nurse Anesthesia Program Students

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DAILY ANESTHESIA APPARATUS CHECKOUT: OBJECTIVE STRUCTURED CLINICAL EXAM (OSCE) FOR FIRST YEAR NURSE ANESTHESIA PROGRAM STUDENTS

by

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A Doctoral Project
Submitted to the Graduate School,
the College of Nursing and Health Professions
and the School of Leadership and Advanced Nursing Practice
at The University of Southern Mississippi
in Partial Fulfillment of the Requirements
for the Degree of Doctor of Nursing Practice

Approved by:

Dr. Nina McLain, Committee Chair
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December 2021

Published by the Graduate School

ABSTRACT

The anesthesia apparatus checkout is a vital task an anesthesia provider should be able to perform upon entering the clinical setting. In the past, more than half of anesthesia-related deaths throughout the nation were being attributed to assessable and avoidable causes involving the anesthesia machine. Therefore, the U.S. Food and Drug Administration (FDA) formulated and recently revised a detailed anesthesia apparatus checkout procedure to ensure patient safety within the operating room setting. Entering the clinical arena for the first time can be quite intimidating for anesthesia students; therefore, the objective structured clinical exam (OSCE) was developed with the intention that first-year students incorporate this study tool into their study routine. The purpose of the OSCE is to provide students with the appropriate information to assess for machine malfunctions and adequately perform an anesthesia apparatus checkout that could ultimately lead to unanticipated patient injury if not performed.

The anesthesia apparatus checkout procedure OSCE was constructed and presented to The University of Southern Mississippi second and third-year SRNAs and four anesthesia faculty members, along with an anonymous evaluation survey. Twenty-five individuals contributed to the anonymous survey with all but one agreeing that the OSCE was clear and concise in delivery. The same theme applied to readiness and confidence within oneself when entering the clinical setting. All survey participants indicated that after the completion of the anesthesia apparatus checkout OSCE, everyone could adequately perform and understood each factor of the anesthesia apparatus checkout. Survey participants did not provide any additional feedback or suggestions to better improve the OSCE. Overall, it was concluded that the anesthesia apparatus

checkout OSCE prepares future anesthesia providers with the confidence and knowledge needed to adequately perform the required daily routine, making their transition into the clinical arena less stressful while ensuring patient safety and positive outcomes within the operating room setting.

ACKNOWLEDGMENTS

We would like to express our utmost appreciation to our committee chair, Dr. Nina McLain, for her support, leadership, expertise, and patience throughout the completion of the project. We would, also, like to thank our committee member, Dr. Mary Jane Collins, for her encouragement and feedback throughout this process to perfect our project that will be incorporated into her syllabus. Finally, we want to acknowledge and show gratitude to the survey participants for taking time to review and provide constructive criticism and feedback on the project. Without the support and direction from every one of these individuals, the final product of the project would not have been achievable.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF ILLUSTRATIONS

LIST OF ABBREVIATIONS

AACN	American Association for Colleges of Nursing
AANA	American Association of Nurse Anesthesiology
APL	Adjustable Pressure-limiting
ASTM	American Society for Testing and Material
CRNA	Certified Registered Nurse Anesthetist
DISS	Diameter Index Safety System
DNP	Doctor of Nursing Practice
EBP	Evidence Based Practice
FDA	U.S. Food and Drug Administration
IRB	Institutional Review Board
N_2O	Nitrous Oxide
NAP	Nurse Anesthesia Program
OSCE	Objective Structured Clinical Examination
O_2	Oxygen
PISS	Pin Index Safety System
PSIG	Pound per Square Inch Gauge
SRNA	Student Registered Nurse Anesthetist
USM	The University of Southern Mississippi

CHAPTER I – INTRODUCTION AND BACKGROUND

Surrounding the formation of the anesthesia apparatus checkout developed by the U.S. Food and Drug Administration (FDA) in 1993, more than half of the anesthesia-related deaths throughout the nation were being attributed to assessable and avoidable causes involving the anesthesia machine (Henry, 1989). Due to this high mortality and morbidity rate being credited to a mix of anesthesia and human error, the FDA quickly began to search for a solution arriving at a detailed daily checklist to ensure patient safety. This procedural list has undergone modernization once in 2008 since its formation showing its stability and relevance in anesthesia practice (March & Crowley, 1991). Due to the importance of machine safety in anesthesia practice, the safety check procedure is taught as part of the educational process with the intention of students committing this process to memory and making it second nature in the clinical setting. However, when it comes to teaching and assessing retention and execution of this process, no one assessment tool is present to ensure every future student registered nurse anesthetist (SRNA) is evaluated on the basis of one specific standard ensuring efficacy of the process. According to the literature, an OSCE is a way to present a consistent appraisal tool of student comprehension. With the completion of this project, an OSCE tool with supporting evidence behind the success of this structure will be formulated to assist in knowledge evaluation for participating nurse anesthesia programs.

Problem Description

Objective structured clinical examinations (OSCEs) have been popularized since the 1970s throughout medical and nursing programs as well as select advanced nursing specialties (Liddle, 2014). However, when it comes to advanced nursing specialties,

nurse practitioner programs tend to take advantage of the application of OSCE's for skill development, whereas nurse anesthesia programs fail to make use of this teaching and evaluation tool. Due to this gap in education across anesthesia programs, inconsistencies in clinical knowledge and practices exist with all students entering the hospital setting. Without the appraisal of academic and applied knowledge, which is obtainable with OSCE's, each student's knowledge base is varying and feeble (Liddle, 2014). This educational gap presents a major problem for nurse anesthesia students due to the required skillset of this profession being highly advanced and adjacent to life or death for patients.

Statement of the Problem

The absence of OSCEs in nurse anesthesia education has the potential to leave room for irregularities in knowledge retention and skill proficiency and a lack of objective evaluation of the student. This educational deficit may create a harmful environment for patients which can potentially lead to injury or death (Chiu et al., 2012). There are numerous competencies in which students must commit to memory in order to be successful in the clinical setting while in school. One of the main skillsets taught throughout the program is the anesthesia machine check. This expertise is taught early on in order to gain mastery before the students enter the hospital setting. Failure to properly perform an anesthesia machine inspection is very detrimental in terms of patient safety and the prevention of complications and injuries. Without a proper assessment of the anesthesia machine, patient traumas can occur from numerous malfunctions including inadequate oxygen or pressure delivery to excessive airway pressures (Goneppanavar & Prabhu, 2013). These injuries can lead to increased patient expenses and prolonged

hospital stays due to further unexpected injuries. However, all these negative consequences due to human error may be avoided by a simple daily anesthesia machine check in order to detect and prevent these complications (Chiu et al., 2012). In addition, for an anesthesia provider to adequately perform an inventory of the anesthesia machine, practitioners should have a strong educational basis behind the function and possible malfunctions behind the anesthesia machine. In order to instill proper understanding and mechanics for this procedure, an OSCE outlining and appraising the execution of this technique should be implemented in nurse anesthesia programs. This educational tool will provide the students the opportunity to cement the appropriate information to assess for machine malfunctions and avoid patient-related incidents due to these failures.

Significance of the Project

Without a concrete understanding of the anesthesia machine check process and its importance, a number of potential malfunctions can be overlooked by the anesthesia provider potentially leading to unanticipated patient injury. This typically leads to further illness and expenses experienced by the patient which otherwise could have potentially been avoided by a simple survey of the anesthesia machine (Goneppanavar & Prabhu, 2013). However, a major way to avoid this dilemma would be to ensure that The University of Southern Mississippi's (USM) Nurse Anesthesia Program (NAP) utilizes the developed OSCE for anesthesia apparatus checkouts in order to fill the gap which currently exists within the educational system. This program currently does not have a consistent method but wishes to utilize a uniform method of evaluation for the machine check. The improvement in diligence to detect errors in functioning with the anesthesia machine through advanced training has been demonstrated with residents at Ottawa

Hospital. This program intensified its studies into anesthesia machine checks with an upcoming class of residents and compared their learnings with an older resident group. The results showed that further education into the reasonings behind this process heightened the residents' ability to identify machine faults (Chiu et al., 2012). Therefore, the introduction of an OSCE into nurse anesthesia programs would be a way to strengthen students' understanding of the machine and ability to inspect its function. Another benefit that an OSCE with a supplemental video outlining the process can offer students is the ability to explicitly utilize the audiovisual portion. Students have the opportunity to view the video while hands-on practicing the anesthesia apparatus checkout in real-time with the ability to pause, rewind, and replay portions of the video when the SRNA sees fit. The OSCE could, in the long run, have a better impact on patient outcomes and expenditures through the avoidance of any complications.

Anesthesia Machine

In order to understand the detriments behind anesthesia machine malfunctions and the negative impacts on patient safety, a complete understanding of the machine itself should occur. The design components of the anesthesia machine are divided into multiple subsets including but not limited to emergency ventilation equipment, three different pressure systems, the scavenging system, and the monitoring equipment. Each component plays a vital role in the overall function of the machine and the support of the patient.

High-Pressure System

The anesthesia workstation gas supply system can be broken down into three pressure systems, all playing a significant role in the delivery of inhalation anesthesia to

patients. The high-pressure system is the first division of the pressure system inside the anesthetic machine that extends from the gas cylinders to the high-pressure regulators. When operating in the hospital setting, the high-pressure system remains inactive as the central gas supply is the primary source of gas for the anesthesia workstation. However, in the event of the central gas supply failure, the high-pressure system must be properly functioning and attached to an oxygen cylinder to serve as the backup oxygen supply. The high-pressure system is responsible for receiving gases from the gas cylinders at high pressure and reducing the pressure to a more fixed pressure that is suitable for use within the anesthetic machine (Gurudatt, 2013). This pressure system is made up of a group of components capable of receiving gases at cylinder pressure. Multiple units make up the high-pressure system including hanger yoke, yoke block, cylinder pressure gauge (bourdon gauge), and pressure regulator (regulator).

Hanger Yoke. The hanger yoke assembly is the way in which gas cylinders attach to the anesthesia workstation. The yoke assembly is made up of index pins, a washer, a gas filter, and a check valve which are responsible for safely securing each gas cylinder, providing a gas-tight seal, and establishing a unidirectional gas flow to the workstation (Butterworth et al., 2018). This assembly employs a pin index safety system (PISS), which is a safeguard method to prevent medical gas errors via accidental connection of the wrong gas cylinder. This safeguard method includes two metal pins that are precisely arranged on the yoke assembly to correspond with the patterned holes on the gas cylinder head-way valve (Miller, 2015). The hanger yoke valve has five pins for the E-cylinders, with each gas cylinder having a specific universal pin system. The standard requirement for the anesthesia workstation states that there should be at least one yoke assembly for

the oxygen (O_2) and nitrous oxide (N_2O) cylinder (Gurudatt, 2013). It is also suggested to have a double yoke assembly for O_2 for anesthesia workstations being used in areas without piped gases to ensure adequate oxygen supply. All yoke assemblies must be appropriately labeled for the intended gas cylinder.

E-Cylinders. E-cylinders are the most common high-pressure source of gases used for the backup gas supply for the anesthesia workstation (Butterworth et al., 2018). Gas cylinders follow a color-coded scheme for easy identification. Green represents the oxygen cylinder, blue represents the nitrous oxide gas cylinder, and yellow presents the air gas cylinder (Butterworth et al., 2018). These cylinders are used for emergencies only and when the pipeline gas supply is not available. E-cylinders must be stored at seventy degrees Fahrenheit. As previously mentioned, each E-cylinder consists of a unique pin-index configuration to prevent inaccurate misconnections of gas cylinders. A full tank of oxygen in an E-cylinder has a pressure of 1900 psig, while a full tank of nitrous oxide has a pressure of 745 psig. This pressure is lowered to 45 psig when supplied to the anesthesia machine. The cylinder pressure gauge provides the anesthesia provider with the cylinder pressure level.

Cylinder Pressure Gauge (Bourdon Gauge). The cylinder pressure gauge, or commonly referred to as the bourdon gauge, is responsible for displaying the cylinder pressure for the intended gases connected to the anesthesia workstation. When exposed to gas pressure, a flexible tube straightens resulting in the movement of a needle pointer to display the appropriate cylinder pressure (Gurudatt, 2013). Most anesthesia workstations display three bourdon gauges for the most common gases used during surgical procedures. These gauges include oxygen, nitrous oxide, and air. Each bourdon gauge is

color-coded to match the corresponding gas cylinder for easy identification. Bourdon gauges assist anesthesia providers on the proper time to exchange E-cylinders to ensure there is an adequate supply of gases within the cylinders. The E-cylinders must be "open" for the bourdon gauge to display an accurate pressure reading.

Pressure Reducing Device. As previously discussed, E-cylinders provide anesthetic gases at a high and variable pressure which is significantly higher than that of the pipeline gas supply. This considerably high pressure can be hazardous to the patient and difficult to control gas flows (Butterworth et al., 2018). Pressure regulators, or pressure-reducing devices, are diaphragm valves that are responsible for improving safety and guaranteeing optimal use of the cylinder gases. These devices decrease the cylinder gas pressures to a much lower, fixed pressure. The significant reduction in pressure allows for a more controlled and constant flow of gases within the anesthesia machine. The pressure regulators lessen the cylinder gas pressure to 45 to 47 psig. This pressure is slightly lower than the pipeline supply pressure and is a safety feature of the anesthesia machine. If an E-cylinder is left open, this safeguard device ensures that the machine carries gases from the preferred pipeline supply and conserves the gases of the E-cylinders if there were to be a pipeline supply failure (Miller, 2015). However, it is important to keep all E-cylinders closed during normal use to prevent emptying of the gas cylinders.

Intermediate Pressure System

Once the gases have made it through the high-pressure system, it then enters the intermediate pressure system. This system further reduces the gas pressures between 37 and 55 pounds per square inch gauge (PSIG) (Gurudatt, 2013). The intermediate pressure

system is made up of the pipeline inlet connections, pipeline pressure indicators, piping, gas power outlet, master switch, oxygen pressure failure devices, oxygen flush valve, second stage reducing device, and the flow control valves. Each component plays a significant role in providing a safe anesthesia environment.

Pipeline Inlet Connections and Pressure Indicators (Gauge). A piping network is used to deliver oxygen, nitrous oxide, and sometimes air from the hospital's central supply to patient care areas at a pressure of 50 to 55 psig. (Butterworth et al., 2018). Like other features on the anesthetic machine, the piping tubing is color-coded and uses a noninterchangeable diameter-index safety system (DISS) for connecting to the anesthesia machine. The DISS is a safety feature designed to prohibit improper hose connection of gases by making the connection nipple and bore diameter of the body on the anesthesia machine unique for each supplied gas (Butterworth et al., 2018). As the gases flow through the piping tubing and enter the anesthesia machine, it is then filtered to remove debris from the wall supply and flows through a one-way check valve to prevent the backflow of gases into the pipeline supply. The pipeline oxygen pressure is calculated by a pressure gauge and displayed on the front of the anesthesia machine.

Oxygen Flush Valve. The oxygen flush valve provides a high flow rate of 100% oxygen directly to the breathing circuit, bypassing the anesthetic vaporizers (Miller, 2015). This function on the anesthesia machine is one of the oldest safety features and continues to be a required machine standard. Oxygen flow from the intermediate-pressure system feeds the flush valve, which then enters the low-pressure system from the gas vaporizers at a rate between 35 and 75 L/minute (Miller, 2015). Malfunctioning oxygen

flush valves have resulted in many documented patient hazards; therefore, it is essential to assess the function of the valve during the anesthesia machine check.

Pneumatic Safety Systems. Within the gas supply system, there is a pneumatic safety device that was created to prevent the delivery of a hypoxemic gas mixture to the patient (Miller, 2015). This safety device, in particular, restricts the capability of administering an extreme concentration of nitrous oxide in relation to oxygen. As an American Society for Testing and Material (ASTM) standard, the pneumatic safety device must be designed so that when there is a reduction in the oxygen supply pressure below the manufacturer specified minimum, the administration of oxygen concentration does not fall below nineteen percent at the common gas outlet (Miller, 2015). In doing so, this prevents the delivery of a hypoxemic gas mixture to the patient, which is a primary safety goal for modern anesthesia machines. Several safety devices features to decrease the risk of delivering a hypoxic gas mixture in the event the oxygen pressure was to drastically decrease.

Oxygen Supply Failure Alarm Sensor

The oxygen supply failure alarm sensor can detect when the oxygen pressure drops below the manufacturer-specified minimum. When the oxygen pressure drops below the specified value, an audible and visual alarm will notify the anesthesia provider. This alarm sensor cannot be silenced and is required by the ASTM (Miller, 2015). Manufacturer-specified minimum pressure varies amongst the different anesthesia machines due to the different pressure standards worldwide (Miller, 2015). However, all machines have the same components and when the pressures fall below said value, the

pipeline and tank electronic pressure transducers send information to the central processor, which in turn sounds an alarm.

Oxygen Pressure Failure Devices

Present in most anesthesia workstations, the oxygen pressure failure device prevents the administration of nitrous oxide, air, and other gases to the patient unless there is a sufficient supply of oxygen pressure (Butterworth et al., 2018). These fail-safe valves are safeguards within the anesthesia workstation to help decrease the risk of accidental administration of a hypoxic mixture in the event of oxygen supply failure (Butterworth et al., 2018). The fail-safe valves are entirely controlled by the oxygen supply pressure within the intermediate pressure system. As the oxygen pressure decreases, the failure devices either shut off or proportionally decrease the flow of the other gases being delivered.

Second Stage Reducing Device. Second-stage pressure regulators, or reducing devices, deliver fixed pressures to the proportioning system and flow control valves regardless of variations in hospital pipeline pressures (Miller, 2015). These pressure regulators lower the pressure levels between 14 and 35 psig.

Low-Pressure System

The low-pressure system is the final pressure system in which gas pressure changes, lowering to just above atmospheric pressure (Gurdatt, 2013). Most leaks within the gas supply system occur in the low-pressure system. This system's main components consist of the flow control valves, the flowmeters, the vaporizer manifold, and the anesthetic vaporizers.

Flow Control Valves. The rate of flow of the gases is determined by the flow control valves after the pressure supply has been reduced to a safe level. The flow control valves are composed of the control knob, stem, and seat. Like other gas supply components, the control knobs for each gas are color-coded and touch-coded (Gurdatt, 2013). In particular, the oxygen control knob must be noticeably different and larger in diameter from the other gas control knobs (Miller, 2015). The standard requirement for the control knobs on the anesthetic machines is that they all must be at least 25mm apart from one another. To open the gas flow in the flow meters, the control knobs are turned counterclockwise and clockwise to close the gas flow. The stem of the flow control valve is connected to the control valve. On the distal portion of the stem is a pin, which determines the flow of gas. If the valve is closed, then there is no gas flow. On the contrary, when the stem is turned counterclockwise a small opening is made between the pin and the stem allowing gas flow into the flowmeter. The main purpose of the flow control valves is to regulate the flow of gases entering the low-pressure system.

Flowmeter Sub-Assembly. The flow meter sub-assembly is responsible for controlling, measuring, and indicating the amount of gas flow passing through to the common gas outlet. The sub-assembly is made up of multiple components all having a specific job of their own. Thorpe tube flowmeters, or flow meter tubes, are glass instruments used to directly measure the flow of gases through the anesthesia machine. Thorpe tubes are capable of measuring both high and low flow rates of the gases. There are single tapered or double tapered flowmeter tubes. Single tapered Thorpe tubes are used when separate tubes are used for the flow rates of the same gas. On the other hand, double tapered flowmeter tubes are used when there is only a single flowmeter tube being

used. The upper portion of the double tapered tube directly measures high flow rates, where the lower portion measures low flow rates. The bobbin, or float, is present in all flowmeters and indicates the amount of flow into the tube. The indicator moves up and down and rotates depending on the amount of gas flowing in. The bobbins are designed to rotate to show that gases are flowing through the tube and the bobbin is not stuck. The Thorpe tubes and the bobbin are assembled and calibrated as a whole for each gas; therefore, it is important to change the assembly as a whole when broken. The flow meter scale is marked directly on the flow tube or can be found to the right. As previously mentioned, the bobbin indicates the accurate rate of gas flow when used in relation to the scale. Gas flow measurements are read at the top of the indicator. The flowmeters and other corresponding components were strategically designed to precisely measure the flow of gases.

Sequence of Flowmeter

The sequence of the flow meters of the gases are an important aspect of the anesthesia machine. To prevent the delivery of a hypoxic mixture to patients, the oxygen flow meter must always be downstream from all other gases. Positioning the oxygen flow meter downstream from nitrous oxide will be administered a higher fraction of inspired oxygen in the event of a leak in the middle flowmeter tube. Although this may result in a lighter anesthetic, this particular positioning of the gases prevents hypoxemia and there is a lower chance of creating a hypoxic mixture in the event of a leak. It is an ASTM standard to have the oxygen flowmeter downstream from all other gases (Miller, 2015).

Proportioning System

Like other systems within the anesthesia machine, the proportioning system is a safety component to prevent the delivery of hazardous gas supplies to patients. This system is considered to be the most important pneumatic safety component within the gas supply system of the anesthesia machine (Miller, 2015). Again, this is an ASTM standard for the anesthesia workstation. This standard states that the workstation must be equipped with a safety device to protect against an "operator selected delivery of a mixture of oxygen and nitrous oxide having an oxygen concentration below 21% oxygen in the fresh gas or inspiratory gas" (Miller, 2015, p. 763). There are two proportioning systems that vary among manufacturers' designs of the anesthesia machine. A pneumatic mechanical interlock system device was designed to link both the oxygen and nitrous oxide flows to automatically limit the flow of 75% nitrous oxide to 25% oxygen into the breathing circuit (Miller, 2015). Different from the interlocking system, the oxygen and nitrous oxide flow control valves are mechanically linked to prevent the mixture when manipulated. The proportioning system, located within the anesthesia machine, maintains a 3:1 ratio of nitrous oxide to oxygen. When operator-selected gas delivery is being administered, the proportioning system prevents the delivery of a hypoxemic gas mixture.

Unidirectional Check Valve. Unidirectional valves, or one-way valves, allow the flow of gases through the breathing circuit in one direction. There are two valves, an inspiratory valve, and an expiratory valve. These valves are an important element of the anesthesia workstation and are one of the most common malfunctions to occur. Incompetent unidirectional valves can result in the rebreathing of carbon dioxide (Miller,

2015). Therefore, it is essential for anesthesia providers to assess the function of these valves when performing an anesthesia machine check.

Pressure Relief Device. The adjustable pressure-limiting valve is a relief valve, controlled by the anesthesia provider, that vents excess breathing circuit gases to the scavenging system. The pressure relief valve can also be used to control the breathing system pressure during spontaneous modes of ventilation. Anesthesia providers can accurately control continuous positive airway pressure when using the adjustable pressure-limiting (APL) valve during spontaneous ventilation (Miller, 2015). The APL valve function is closed off when the ventilator is switched to assist modes.

Vaporizer Mounting Devices and Interlocking System. Vaporizer mounting devices provide operators the ability to remove and replace anesthetic vaporizers on the anesthesia workstation. When mounting anesthesia vaporizers to the anesthetic machine, the anesthesia provider should ensure that the vaporizers are accurately and strongly seated on the mounting device. Inappropriately seated vaporizers can result in fresh gas flow obstruction or low-pressure systems leaks. Therefore, following the mounting of an anesthetic vaporizer, a low-pressure system leak test must be performed by the operator.

Every anesthesia machine must have a vaporizer interlock system. This device prevents the use of multiple vaporizers simultaneously. The interlock system inhibits the anesthetic workstation from providing fresh gas flow to more than one vaporizer at a time. In doing so, the operator is unable to turn the dial of an anesthetic vaporizer if another vaporizer is already in use. Although this is a safety feature of the anesthesia machine, anesthesia providers must be aware that the interlocking system can fail, potentially resulting in an anesthetic overdose (Miller, 2015). It is essential that operators

inspect and test the vaporizer interlocking system when performing a daily workstation check.

Anesthetic Vaporizers. Anesthetic vaporizers house inhaled anesthetic gases on the anesthesia workstation. The three most common anesthetic vapors used today include Desflurane, Sevoflurane, and Isoflurane. The anesthetic vaporizers have a "concentration-calibrated dial" that accurately administers anesthetic gases to fresh gas flows (Butterworth et al., 2018, p. 55). These vaporizers are situated between the flowmeters and the common gas outlet within the anesthesia workstation.

The physics behind each anesthetic gas is very complex and requires that each inhaled gas be stored in specific anesthetic vaporizers to keep its appropriate form. For example, these volatile liquids quickly evaporate when introduced to air or other gases, therefore the gases must be contained within the vaporizer. Each anesthetic gas has its own unique property values making each one a little different than the other. Related to the anesthetic vaporizers, the boiling point plays a significant role in the types of vaporizers need for each gas. Of the three inhaled anesthetic gases previously mention, Desflurane has a boiling point different from the other two. The different temperature requirement results in this particular anesthetic gas being housed in a different anesthetic vaporizer.

There are multiple anesthetic vaporizers that can be found on the anesthesia workstation. The copper kettle, modern conventional vaporizers, and electronic vaporizers are common vaporizers known to anesthesia providers. Each of these vaporizers differs in the way in which the anesthetic gases are diluted with fresh gas flows and administered to patients.

Copper Kettle

Although not used today, the copper kettle vaporizer was the first-ever vaporizer used to administer volatile anesthetics. It is essential for anesthesia providers to understand the way in which the copper kettle vaporizer works to fully grasp the delivery of volatile anesthetics. The copper kettle, also known as the measure-flow vaporizer, is dependent on the dedicated flowmeter to determine the amount of carrier gas that seeps through the volatile anesthetic (Butterworth et al., 2018). Copper is the metal of choice for kettle vaporizers related to the chemical properties it possesses. Copper is an extremely good heat conductor with relatively high specific heat and high thermal conductivity (Butterworth et al., 2018). These particular properties strengthen the ability of the vaporizers to maintain a constant temperature. As gases travel through the copper kettle vaporizer, they become saturated with anesthetic vapor. These saturated vapors must be further diluted before entering the patient because the vapor pressure is significantly greater than the partial pressure (Butterworth et al., 2018).

Modern Conventional Vaporizers

Modern conventional vaporizers, also known as a variable-bypass vaporizers, are most commonly seen on anesthesia workstations today. These vaporizers are temperature corrected and agent-specific. Each vaporizer is calibrated specifically to each anesthetic gas related to its physical properties and clinical concentrations (Butterworth et al., 2018). Variable bypass vaporizers are equipped with an automatic temperature-compensating device that expands or contracts depending on changes in temperature. When the temperature decreases, these devices move in such a way as to increase the amount of gas entering the vapor chambers. Vice versa, when there is a rise in

temperature the temperature-compensating strips bend the opposite way inhibiting the amount of gas flow into the chambers (Butterworth et al., 2018). These anesthetic vaporizers have safety features that aid in eliminating or minimizing potentials hazards that have once been associated with them.

Today, modern conventional vaporizers are agent-specific with a keyed filling port to prevent misfiling of the anesthetic agents. Inappropriate filling of anesthetic gases into vaporizers can result in overdose or underdose of the anesthetic agents (Butterworth et al., 2018). Since introducing the key filling port, the potential for misfiling with the incorrect agent has been reduced. Anesthesia providers must also be careful with transporting, removing, or replacing variable bypass vaporizers. Excessive tilting of the vaporizers can cause the volatile agent to spill into the bypass chamber resulting in the delivery of extremely high concentrations of the anesthetic agent (Miller, 2015). In the event that excessive tipping has occurred, vaporizers should be flushed at high flow rates for an extended period to guarantee the removal of the liquid anesthetic from the bypass chamber. Most vaporizers today are strongly settled to the anesthesia machine via the vaporizer manifold; therefore, issues related to tipping rarely occur. One must be vigilant when filling modern conventional vaporizers. Overfilling can result in excess anesthetic agents spilling into the bypass chamber leading to a high vapor concentration, potentially resulting in an anesthetic overdose. As a safety feature, it is a designed requirement that the fill port is located on the side of the vaporizer (Miller, 2015). By placing a side-fill port on the variable bypass vaporizers, restricts overfilling from occurring because the maximum amount of liquid anesthetic is at the level of the fill port. Although these

safeguards prevent a hazardous event from occurring, anesthesia providers must be cautious when filling, transporting, replacing, or removing vaporizers.

Electronic Vaporizers

Electronic vaporizers are specifically used for the volatile anesthetic, Desflurane. Due to Desfluranes vapor pressure, which is three to four times higher than other anesthetic gases, the agent must be electrically heated to safely administer to patients (Butterworth et al., 2018). An excessively high gas flow rate would be required to dilute the volatile liquid anesthetic within the chamber to harmless clinical concentration (Miller, 2015). Much different than the modern conventional vaporizers, fresh gas flow does not flow through the desflurane sump, rather the liquid anesthetic joins the gas mixture right before exiting the electronic vaporizer. The operator controls the desflurane concentration by the amount of fresh gas flow rate and turning the control dial (Butterworth et al., 2018). Like modern-conventional vaporizers, electronic vaporizers also have safety features. Similar to other vaporizers, electronic vaporizers have an anesthetic-specific filling system and a filling system to prevent overfilling of the anesthetic gas.

Common (Fresh) Gas Outlet. The common gas outlet, or fresh gas outlet, is the only gas outlet that supplies fixed gases to the breathing system (Butterworth et al., 2018). An anti disconnect retaining instrument can be found on all anesthesia machines to inhibit inadvertent disengagement of the outlet hose from the anesthesia machine and breathing circuit. Bypassing the flowmeters and vaporizers, the common gas outlet obtains a high flow rate of oxygen to swiftly refill or flush the breathing circuit from the oxygen flush valve (Miller, 2015). As previously mentioned, providers must use caution

when utilizing the oxygen flush valve while the breathing circuit is connected to the patient. There is a significant potential of causing barotrauma to the patient due to the high pressure of gases flowing to the breathing circuit when the oxygen flush valve is activated (Butterworth et al., 2018).

Soda Lime Absorbent. Soda-lime absorbers, or carbon dioxide absorbers, are responsible for removing carbon dioxide from exhaled gases. The removal of carbon dioxide from exhaled gases is essential to avoid rebreathing carbon dioxide and hypercapnia (Miller, 2015). The absorber is composed of numerous granules with a chemical absorbent that breaks down the exhaled carbon dioxide.

Scavenging System

The scavenging system is responsible for collecting and removing excess waste of anesthetic gases from the anesthesia machine and the anesthetizing location (Miller, 2015). All anesthesia machines are required to have this function because there is a more than necessary delivery of anesthetic gases and nitrous oxide. The sole purpose of the scavenging system is to minimize the pollution of excess gases into the operating room.

Monitors

Standard Nine of the American Association of Nurse Anesthesiology (AANA) Standards for Nurse Anesthesia Practice states that all anesthesia providers must monitor, evaluate, and document the patient's physiologic condition for a procedure and anesthetic technique (AANA, 2019). When using a monitoring device during such procedures and anesthetic techniques, alarms with variable pitches and thresholds must be activated and audible. According to Standard Nine (AANA, 2019), the required areas to be specifically monitored while anesthesia is provided include oxygenation, ventilation, cardiovascular

(hemodynamics), thermoregulation, and neuromuscular response if neuromuscular blocking agents were administered. When conducting the anesthesia apparatus checkout, anesthesia providers must check, calibrate, and/or set alarm limits of the monitoring systems mentioned above. As stated by the FDA Anesthesia apparatus checkout recommendations, the following monitors must be inspected before the first case of every day including capnography, pulse oximeter, oxygen analyzer, respiratory volume monitor, and pressure monitor with high and low airway-pressure alarms (ASA, 2021). Properly functioning and audible monitoring systems enhance safety within the operating room by notifying anesthesia providers of deviations in values from normal clinical ranges or when there has been a disconnect within the anesthesia machine.

Rationale

Prior to the development of the anesthesia machine checkout, more than half of anesthesia-related deaths stemmed from preventable machine malfunctions. The FDA promptly developed an anesthesia apparatus checkout process that is required to be performed daily in an attempt to avoid harmful events related to machine malfunctions. It is essential that all anesthesia providers have an understanding of the different pressure systems within the anesthesia machine and know how to appropriately perform a machine check to ensure patient safety and avoid such detrimental events. Implementing an OSCE on the anesthesia apparatus checkout procedure, developed by the FDA, could provide student nurse anesthetists with an educational video and template on the proper steps required to perform a daily machine check (Henry, 1989). By utilizing the OSCE, students should gain a foundation of knowledge, skillset, and confidence before entering the clinical environment.

Specific Aims

The aims for the OSCE on the anesthesia apparatus checkout procedure are geared towards bettering student knowledge surrounding machine checkoffs which would in turn would potentially cause a rippling effect increasing patient safety. In order to accomplish this task, several aims would need to be met. Firstly, consistency in regard to the content utilized by the program to teach this process would need to be established. Consistency can be accomplished by putting forth an evidence-based teaching plan and OSCE template to provide a clear guideline for the students on learning responsibilities and expectations. Secondly, a standardized method through which students could practice and learn this technique should be established. As previously mentioned, an OSCE template would be ideal to accomplish this task as well as a tutorial video for students to visualize and understand the material being presented. Next, a process in which students can be evaluated objectively and dependably across the board should be established along with a method by which students can demonstrate the newly learned skill and feel confident in the anesthesia checkout procedure process. Both of these methods could be established through the implementation of the outlined OSCE.

Summary

The purpose of this project is to increase awareness and knowledge behind anesthesia machine malfunctions and patient detriments related to the failures which could have been otherwise prevented with an adequate machine check. This Doctor of Nursing Practice (DNP) project's main focus is centered around the development and effectiveness of an objective structured clinical examination for the daily and case-by-case anesthesia apparatus checkout developed by the U.S. Food and Drug Administration

(FDA). Providing nurse anesthesia students with an OSCE pertaining to the anesthesia apparatus checkout procedure will allow students to develop adequate skillsets, confidence, and knowledge to appropriately perform anesthesia machine checks upon entering the clinical environment. Proper anesthesia machine checks grant anesthesia providers with the certainty that the anesthesia machine will sufficiently provide crucial life support functions and avoid patient detriments. In Chapter II, we will discuss the different methods and data collection tools utilized in order to research and finalize the project.

CHAPTER II - METHODOLOGY

The University of Southern Mississippi's (USM) College of Nursing and Health Professions requires that all students enrolled in a Doctor of Nursing Practice (DNP) program fulfill DNP Essentials set forth by the American Association for Colleges of Nursing (AACN). The formulation of an OSCE meets these requirements, as well as sets forth better educational and practice expectations for new oncoming CRNAs. A newly created OSCE for an anesthesia machine checkoff before the start of the day, as well as an abbreviated check off before each case, presents a more defined and controlled educational opportunity for future students entering the nurse anesthesia program (NAP) at USM. This OSCE is designed with the intention of patient harm prevention through an improvement of clinical practice standards. Through the incorporation and employment of this OSCE into the NAP curriculum, current and future SRNAs will be presented with the opportunity to effectively and efficiently perform an anesthesia machine check to provide the best care for patients. Upon completion of this OSCE, SRNAs will be able to assist and lead their peers and underclassmen in the subject matter of anesthesia machine checkoffs.

Steps

Numerous steps have been taken to ensure the accuracy and relevance of the information required for the completion of this project. Upon proposing this project to the DNP committee at USM, the endorsement was requested from the Institutional Review Board (IRB-21-140). After being notified of approval from the IRB, a systematic and comprehensive search of best evidence-based practice information was collected and interwoven into the development of an OSCE for SRNAs at USM to better prepare

students entering clinical practice to perform anesthesia machine checkoffs. Along with the collected data and the formulation of an OSCE, an appraisal list was devised for the recruited panel of experts to evaluate and leave criticisms regarding the anticipated usefulness of the OSCE (See Appendix C). This panel of clinical and professional specialists included (a) two CRNAs, (b) three NAP instructors, and (c) a NAP director. This panel was selected due to their depth of knowledge and understanding of the role an anesthesia machine plays in the everyday practice of a CRNA and the detriment that the failure of this machine can cause. Another evaluation was created for a panel of SRNA peers—shown in Appendix B—to offer further critique on the effectiveness of the OSCE. This peer feedback will also provide insight into the ability to interpret and apply this knowledge in the clinical setting by active students.

Intervention

The interventional aim of this project was the formulation of an OSCE to enhance proficiency when performing anesthesia machine checks and further the knowledge surrounding the process to supplement the educational opportunity provided by the USM NAP. The foundation of this OSCE is to prevent detrimental patient outcomes through the performance of thorough and systematic machine checks. The curriculum supplement formed comprises the OSCE (Appendix E), an evaluation checklist to be used by the instructor (Appendix E), and a peer evaluation form (Appendix E). The theory behind the OSCE proposal was developed based on EBP and best practice guidelines with the intent to incorporate modifications based on the critiques from the panel of experts and a peer group of SRNAs.

Measures

The projected effect of this OSCE is the supplement the teaching of anesthesia apparatus checkout procedures within the USM NAP improving clinical outcomes for SRNAs and patients under students' care. The expected expert advice and suggested changes from the panel of specialists will be interwoven into the OSCE to provide the best possible learning experience for current and future SRNAs entering into the USM program. Additionally, the appraisal list offered to current SRNAs will be used to extract data from currently practicing students in clinical to develop the best possible anesthesia apparatus checkout OSCE.

Data Collection and Analysis

Data collection for this project will come in the form of evidence-based literature from a previously published data collection tool, previously developed safe practice guidelines formed by the FDA, and qualitative data collected from a panel of experts and a group of peers. The panel of experts includes (a.) two CRNAs, (b.) three NAP instructors, and (c.) a NAP administrator. The administrator of the NAP will also be utilized throughout the data collection process by aiding to voluntarily recruit other SRNA peers to participate in the OSCE and provide feedback via email. The committee chair will also assist during the data collection process through collecting the feedback forms, and once this process has been completed, interpret, and summarize the available data. Once this stage has been completed, appropriate revisions will be applied to the OSCE for the anesthesia apparatus checkout.

Ethical Considerations

One of the main ethical considerations surrounding patient care within a healthcare system is patient safety. With the implementation of this OSCE, SRNAs will be able to build an adequate knowledge base and formulate a methodical technique around performing an anesthesia apparatus checkout, which in turn, will prevent detrimental patient effects through the failure to complete this important step in preparation. The methods utilized to develop the OSCE for the anesthesia apparatus checkout did not result in any direct patient contact. The panel of experts and group of SRNA peers involved in the revision process will be kept anonymous for confidentiality purposes.

Summary

The purpose of the development of this OSCE goes much further than just to further strengthen the knowledge of students enrolled in the USM NAP. This OSCE sets out to improve current and future students' knowledge, ability, and timeliness when performing an anesthesia apparatus checkout to possibly prevent negative patient effects from failure to complete this step when preparing for the day and each case. The authors of this project gathered a collection of EBP, best practice guidelines, and critiques from two separate panels consisting of experts and peers. The feedback gathered will be entwined back into the project to have the best possible OSCE to better prepare students for the clinical setting. The organizational structure employed to construct this project this OSCE meets the AACN DNP essentials and USM College of Nursing and Health Professions standards.

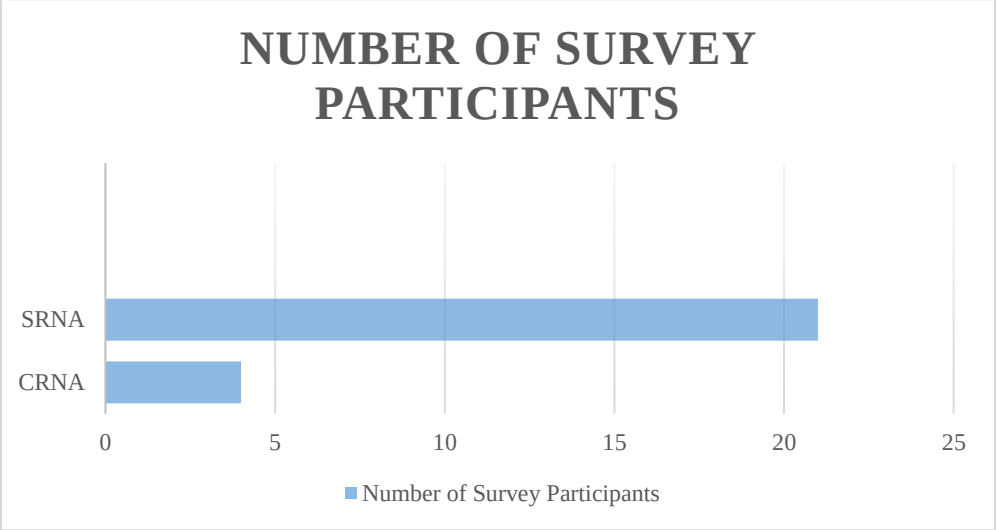
CHAPTER III - RESULTS

Each participant completed a constructive appraisal (Appendix B & Appendix C) of the anesthesia apparatus checkout OSCE (Appendix E). For the data collection process, a survey was distributed to four faculty members of the nurse anesthesia program at USM and thirty-nine students in their second and third years of the nurse anesthesia program. This assessment was centered around the effectiveness of the OSCE and the potential effect of this OSCE for future students' ability to complete the anesthesia apparatus checkout. Two surveys were dispersed to the different experience level groups and included the following areas: the surveyor's consent to participate, the format of the OSCEs presenting to be clear and well defined, the OSCEs ability to appropriately educate future SRNAs, the effectiveness of the OSCE to provide confidence to students in the clinical setting, and an open-ended question requesting additional feedback to better the OSCE for future use.

The appraisal checklist was distributed to each surveyor via email. The email included a rationale behind the benefits of this project for future generations of SRNAs, an invite to partake in the survey, and a link to the data collection tool utilized for this project, Qualtrics. Results were gathered over two weeks after inviting contribution, and a total of twenty-five participants. Of the twenty-five participants, four were CRNAs with previous anesthesia experience, and twenty-one were SRNAs who are currently practicing in a clinical setting, as shown in Table 1 below.

Table 1

Number of Survey Participants



The results for each question were evaluated in order to improve the project. In deciding if the OSCE was clear and concise in delivery, each participant selected strongly agree with the exception of one participant who chose somewhat agree to this parameter. The same theme of all participants selecting strongly agrees with one individual choosing somewhat agree applied to the question asking if participants would feel comfortable entering the clinical setting with the utilization of this OSCE. All survey participants indicated strongly agree with the final inquiry of adequately performing and understanding each factor of the anesthesia apparatus checkout after completion of this OSCE. No one utilized the opportunity to leave additional feedback in regard to the improvement of the OSCE.

Summary

The purpose of this project is to improve future SRNA's understanding and the comprehension behind the anesthesia apparatus checkout procedure and the associated

detriments that occur with failure to comply with this process. The formation of an OSCE helps to put this information into a written and visual format in order to expand the learning process for SRNAs along with an evaluation tool to score the students learning, understanding, and performance. The OSCE along with the paired simulation will allow students the comfort of a simulated setting to test their knowledge base before entering a stressful clinical environment.

CHAPTER IV – DISCUSSION

The purpose of the anesthesia apparatus OSCE is to prepare and improve future SRNAs knowledge and understanding of the anesthesia apparatus checkout process as recommended by the FDA. It is imperative that students are also aware of the detriments that can occur with failure to comply with the checkout procedure, which is also discussed throughout the project. Practicing CRNAs along with second and third-year SRNAs at The University of Southern Mississippi participated in the study. After reviewing the anesthesia apparatus OSCE, uncontested participants collectively agreed that the anesthesia apparatus OSCE incorporated evidence-based practice data with guidelines from the FDA that was clearly and concisely presented, apart from one surveyor. Furthermore, it was agreed upon from all respondents but one that the participants would feel comfortable entering the clinical arena after utilizing and referring to the anesthesia apparatus OSCE preceding the first day of clinical. Collectively, it was agreed upon that all survey participants felt they could adequately perform and understand each factor of the anesthesia apparatus checkout after completion of the anesthesia apparatus OSCE, providing SRNAs with the confidence needed to enter the clinical arena for the first time.

Interpretation

After further examination of the feedback provided by the assessors, it has been determined that the anesthesia apparatus OSCE and demonstration video applying the anesthesia apparatus checkout process recommended by the FDA is beneficial for SRNAs. Providing students with the anesthesia apparatus checkout OSCE allows SRNAs to practice and review the checkout process in a controlled setting in the simulation lab

located in the nursing building. The sim lab setting allows students to refer to the video and step-by-step tutorial until they feel comfortable and confident enough to perform the task without any leads. Students can now enter the clinical setting feeling confident enough along with an understanding of the patient detriments that can occur with failure to complete an anesthesia apparatus checkout.

Limitations

The anesthesia apparatus checkout OSCE limitations included the sample size and the invited participants. The sample size for the project was limited and very small, only consisting of faculty CRNAs and second and third-year SRNAs at The University of Southern Mississippi. The given survey was voluntary with a small number of participants that responded. The project could have had better feedback/response had the OSCE and survey been sent to other anesthesia schools and practicing CRNAs. As previously mentioned, participants for the anesthesia apparatus checkout project consisted solely of faculty and student associated with The University of Southern Mississippi. This limitation could contribute to probable bias. Regardless of the limitations mentioned, the feedback collected allows for a strong project for future SRNAs.

Conclusion

The anesthesia apparatus checkout OSCE, based on the recommended FDA guidelines, was constructed to provide first-year SRNAs with educational information founded on EBP to instill confidence and knowledge in oneself prior to entering the clinical setting. This OSCE has been proposed to The University of Southern Mississippi's Nurse Anesthesia Program to include in their OSCE collection. The project

was constructed with the intent to be incorporated into NUR 837 rubric when teaching the components of the anesthesia machine. The anesthesia apparatus checkout OSCE could also be utilized by other anesthesia and medical programs throughout surrounding areas. With such detriments that can occur with failure to comply with the checkout process, this OSCE provides future anesthesia providers with the information needed to confidently perform such an important task required daily within the clinical setting.

APPENDIX A – DNP Essentials

DNP Essentials	**Clinical Implications**
I. Scientific Underpinning for Practice	The evaluation of literature related to OSCEs and the anesthesia apparatus checkout
II. Organizational and Systems Leadership for Quality Improvement and Systems Thinking	The OSCE has the opportunity to enhance the learning experience for SRNAs and better prepare the students for the clinical setting
III. Clinical Scholarship and Analytical Methods for Evidence-Based Practice	Through dissecting literature to formulate an OSCE based on most current EBP and practice recommendations
IV. Information Systems/Technology and Patient Care Technology for the Improvement and Transformation of Health Care	The project focuses on promoting EBP in order to formulate the most accurate and structured OSCE aiming to better prepare future students
V. Health Care Policy for Advocacy in Health Care	The fifth essential was accomplished by merging EPB with best-practice standards and creating an OSCE to prepare SRNAs to the best of their ability
VI. Interprofessional Collaboration for Improving Patient and Population Health Outcomes	Collaboration was achieved through the utilization of a panel of experts and peers alike who possess a varying knowledge base in order to achieve the best version of an OSCE
VII. Clinical Prevention and Population Health for Improving the Nation's Health	The main goal of this OSCE was to better inform students of the anesthesia apparatus checkout and the reasoning behind this process in order to promote patient safety and prevent injury due to failure of performing this step

VIII. Advanced Nursing Practice	This project's goal was to amplify and further strengthen the curriculum of USMs NAP helping future advanced practice nurses have a strong base of knowledge

APPENDIX B – Expert Evaluation Tool

Evaluation of OSCE for Anesthesia Apparatus Checkout

We greatly appreciate your participation in this evaluation of an OSCE which was created to assist in SRNAs educational advancement with anesthesia apparatus checkouts. While participation is voluntary, your feedback will provide valuable information to assist SRNAs enrolled in USMs NAP.

	Strongly Agree Somewhat Agree Neither Agree nor Disagree Somewhat Disagree Strongly Disagree
1. Do you consent to participate in the evaluation of the OSCE for the anesthesia apparatus checkout?	
2. In your professional opinion, does this OSCE accomplish the goal of adequately educating and instructing future CRNAs on the importance of anesthesia apparatus checkouts?	
3. In your professional opinion, does this OSCE meet the necessary criteria required to help SRNAs enter the clinical setting and be routinely successful in this aspect?	
4. Please add any comments or suggestions you have that will make the OSCE more understandable, efficient, and/or better outlined to make the OSCE more effective in its goal.	

APPENDIX C – OSCE Evaluation Tool

Evaluation of OSCE for Anesthesia Apparatus Checkout

We greatly appreciate your participation in this evaluation of an OSCE which was created to assist in SRNAs educational advancement with anesthesia apparatus checkouts. While participation is voluntary, your feedback will provide valuable information to assist SRNAs enrolled in USMs NAP.

	Strongly Agree Somewhat Agree Neither Agree nor Disagree Somewhat Disagree Strongly Disagree
1. Do you consent to participate in the evaluation of the OSCE for the anesthesia apparatus checkout?	
2. Was this OSCE concise and well-defined in its presentation of the anesthesia apparatus checkout?	
3. Is the OSCE an appropriate length?	
4. Did this educational tool provide you with the appropriate information needed to confidently and complete the anesthesia machine checkout procedure?	
5. After participating in this OSCE are you able to appropriately perform each step of the anesthesia apparatus check out and identify the purpose behind each step?	
6. Do you believe this OSCE will benefit future SRNAs in the anesthesia machine checkout procedure?	
7. Please add any comments or suggestions you have that will make the OSCE more understandable, efficient, and/or better outlined in order to make the OSCE more effective in its goal.	

APPENDIX D –IRB Approval Letter

Office of Research Integrity

THE UNIVERSITY OF SOUTHERN MISSISSIPPI

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NOTICE OF INSTITUTIONAL REVIEW BOARD ACTION

The project below has been reviewed by The University of Southern Mississippi Institutional Review Board in accordance with Federal Drug Administration regulations (21 CFR 26, 111), Department of Health and Human Services regulations (45 CFR Part 46), and University Policy to ensure:

- The risks to subjects are minimized and reasonable in relation to the anticipated benefits.
- The selection of subjects is equitable.
- Informed consent is adequate and appropriately documented.
- Where appropriate, the research plan makes adequate provisions for monitoring the data collected to ensure the safety of the subjects.
- Where appropriate, there are adequate provisions to protect the privacy of subjects and to maintain the confidentiality of all data.
- Appropriate additional safeguards have been included to protect vulnerable subjects.
- Any unanticipated, serious, or continuing problems encountered involving risks to subjects must be reported immediately. Problems should be reported to ORI via the Incident template on Cayuse IRB.
- The period of approval is twelve months. An application for renewal must be submitted for projects exceeding twelve months.
- Face-to-Face data collection may not commence without prior approval from the Vice President for Research's Office.

PROTOCOL NUMBER: IRB-21-140
PROJECT TITLE: Daily Anesthesia Apparatus Checkout: Objective Structured Clinical Exam (OSCE) For First Year Nurse Anesthesia Program Students
SCHOOL/PROGRAM: School of LANP, Leadership & Advanced Nursing
RESEARCHER(S): Lauren Hensleigh, Nina Mclain, Blake Cochran

IRB COMMITTEE ACTION: Approved
CATEGORY: Expedited
7. Research on individual or group characteristics or behavior (including, but not limited to, research on perception, cognition, motivation, identity, language, communication, cultural beliefs or practices, and social behavior) or research employing survey, interview, oral history, focus group, program evaluation, human factors evaluation, or quality assurance methodologies.

PERIOD OF APPROVAL: April 28, 2021

Donald Sacco Jr.

Donald Sacco, Ph.D.
Institutional Review Board Chairperson

APPENDIX E – Objective Structured Clinical Exam for Anesthesia Apparatus Checkout

for Student Nurse Anesthetists

ANESTHESIA OBJECTIVE STRUCTURED CLINICAL EXAM
ANESTHESIA MACHINE CHECKOUT PROCESS AS INDICATED BY THE FDA FROM STUDENT NURSE ANESTHETISTS

LEARNER OUTCOMES:

1. Proper use and functions of the anesthesia machine
2. Be able to identify and explain the different parts/systems of the anesthesia machine that are specifically checked during the anesthesia apparatus checkout
3. Successfully perform an anesthesia machine checkout independently
4. Gain confidence inadequately performing anesthesia machine checkout

DOMAINS:

Clinical Skill, Knowledge Development, Performance Assessment, Formative Evaluation

PURPOSE: Student practice and Performance Assessment

LEARNER OBJECTIVES:

1. Describe the architecture of the anesthesia machine.
2. Identify the importance of performing anesthesia machine checkout daily and before each case.
3. To increase awareness and knowledge behind anesthesia machine malfunctions and patient detriments related to component failures.
4. Demonstrate how to perform the routine anesthesia machine checkout process as indicated by the U.S. Food and Drug Administration.

INDIVIDUAL OR GROUP OSCE: Individual

REQUIRED READING and ASSOCIATED LECTURES:

1. Butterworth, J. F., Mackey, D. C., & Wasnick, J. D. (2018). Morgan & Mikhail's Clinical Anesthesiology (6th edition). McGraw-Hill Education.
2. Lecture PowerPoint – Journey to Excellence Clinical Conference Series: The Anesthesia Machine

REQUIRED VIDEO: Correlating video created for OSCE

REQUIRED PARTICIPANTS: Student Nurse Anesthetist (1st and 2nd year) for Formative Evaluation and Performance Assessment, Examiner

VENUE: The University of Southern Mississippi, Asbury Hall Simulation Lab

STUDENT LEVEL OF OSCE: Semester 3-4

TIME ALLOTED: 15 minutes

SEQUENTIAL PRACTICE & TESTING: No sequential testing may be needed for this exercise

RECOMMENDED PRACTICE PRIOR TO EXAMINATION: 3X is recommended,15 minutes each (45 min total)

CONTEXT:

CONTENT OUTLINE

You are assigned to OR 12 for a robotic hernia repair scheduled to start at 0730. As the nurse anesthetists assigned to this room, demonstrate your knowledge by performing the anesthesia checkout process that should be performed before the first case of the day.

EQUIPMENT& SUPPLIES:

- Anesthesia Machine
- Suction tubing
- Yankauer suction catheter
- Ambu bag
- Device to open and close gas cylinders

SITE SELECTION:
N/A

TASK STATEMENT:
Your task is to identify and describe the different parts/systems of the anesthesia machine that are specifically checked during the anesthesia machine checkout process. You must also successfully perform an anesthesia machine checkout process independently as indicated by the FDA.

PROCESS

1. Verify backup ventilation equipment is available and functioning (ambu bag and suction)
2. Assess components within the High-Pressure System.

    a. Oxygen cylinder supply
    b. Central pipeline supplies
3. Assess components within the Low-Pressure System.
    a. Check initial status
    b. Perform leak check
4. Assess the breathing system.
    a. Calibrate O_2 monitor
    b. Check initial status
    c. Perform leak check
5. Test ventilation system and unidirectional valves
6. Check the Final status of the machine

IMAGES:

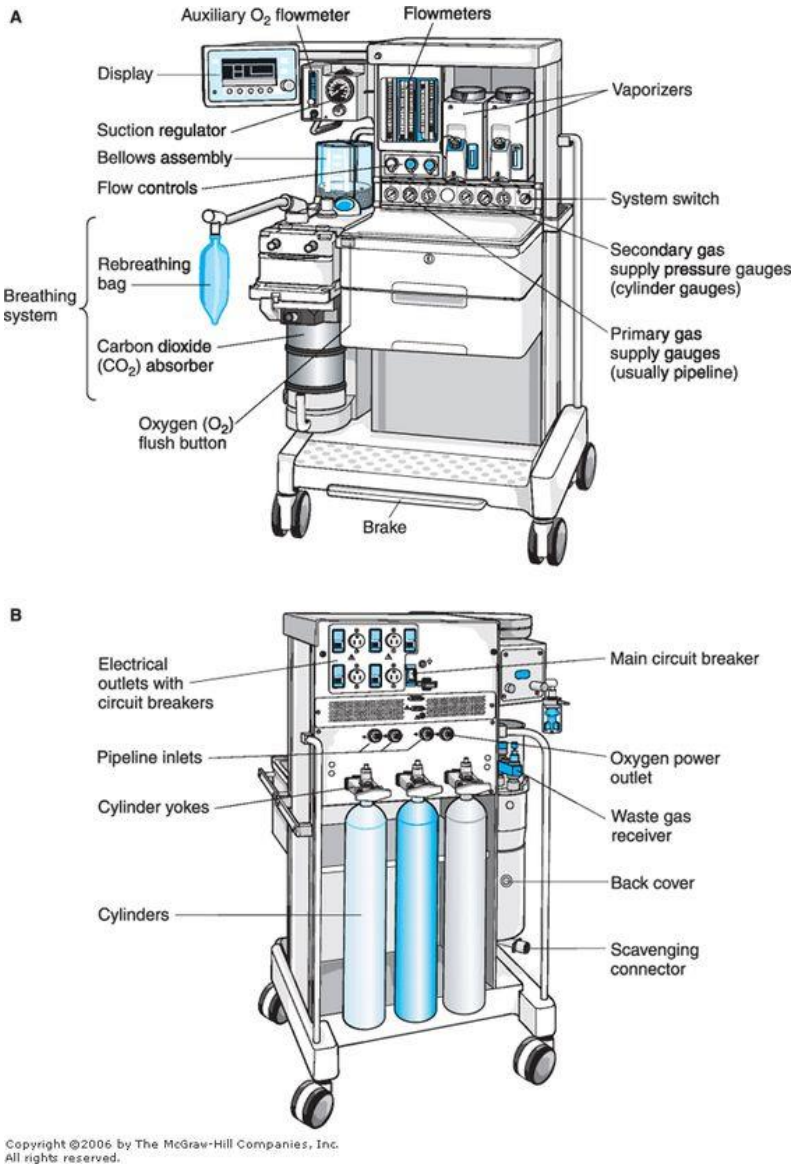

Figure A1. *Labeled components of the anesthesia machine*

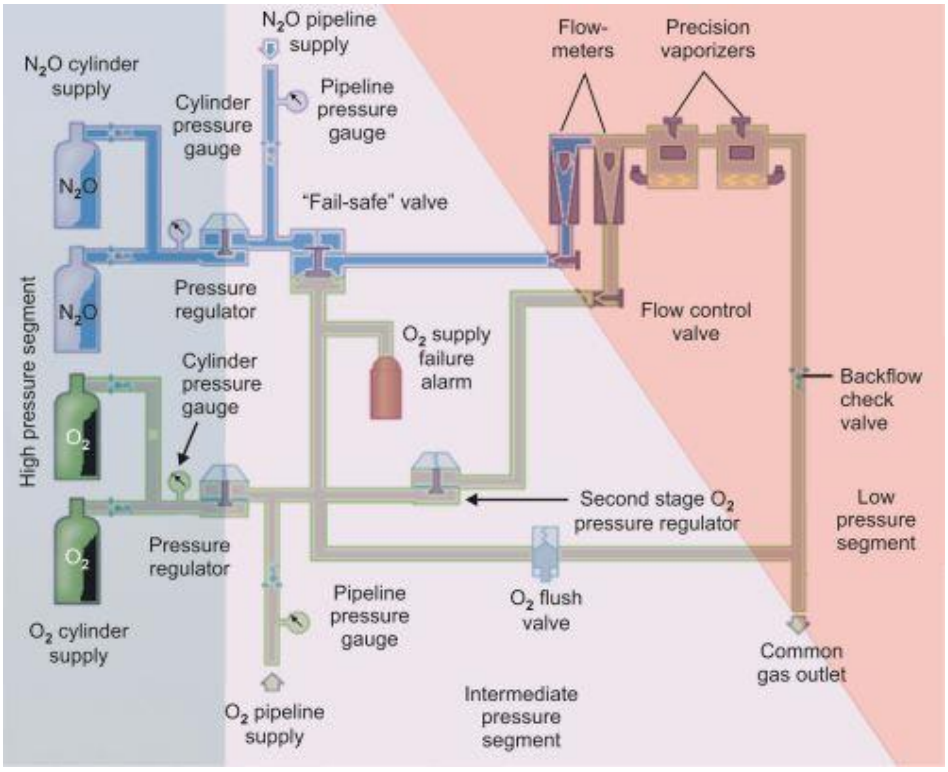

Figure A2. *Color-coded breakdown of the three different pressure systems within the anesthesia machine*

DEBRIEFING FORM:

1. Was the information provided for this OSCE clear and easy to understand?
2. After reviewing the required reading and video, did you have the knowledge and skillset to meet the objectives?
3. Were you satisfied with your ability to confidently perform the anesthesia machine checkout process independently?
4. After completing this OSCE, do you feel prepared to enter the clinical setting?
5. List recommendations, if any, for improving the OSCE to better prepare you for entering clinical practice.

ASSESSMENT

RUBRIC FOR ANESTHESIA MACHINE CHECKOUT PROCESS

QUESTION & DEMONSTRATION STATION:

TASKS	PASS	FAIL	COMMENTS
EMERGENCY VENTILATION EQUIPMENT:			
1. Ambu bag on machine			
2. Suction functioning and available			
HIGH-PRESSURE SYSTEM			
Check Oxygen Cylinder Supply			
3. Open O_2 cylinder			
4. Verify amount in cylinder			
5. Close O_2 cylinder			
6. Verbalize the procedure of opening, reading amounts, and closing of additional O_2 cylinder and N_2O cylinder, if present			
Check Central Pipeline Supplies			
7. Bleed out pressure from cylinder supply. May use O_2 Flush			
8. Check that hoses are connected to pipeline supply			
9. Verify pressure of the pipeline			
LOW-PRESSURE SYSTEM			
Check Initial Status of Low-Pressure System			
10. Close flow control valves			
11. Close Vaporizers			
12. Check fill level of vaporizers			
13. Tighten Vaporizer caps			
14. Verbalize level at which when vaporizers need filling (liquid below lower mark)			
BREATHING SYSTEM			
Calibrate O_2 Monitor			
15. Prompt anesthesia machine to begin O_2 monitor calibration			
16. Expose O_2 analyzer to air			
17. Ensure monitor reads 21% room air			
18. Verify low O_2 alarm is enabled and functioning			
19. Reinstall sensor			
Check Initial Status of Breathing System			

20. Set selector switch to BAG mode			
21. Visually inspect breathing circuit			
22. Verify that CO_2 absorbent is adequate			
Perform Leak Check of Breathing System			
23. Set all flows to zero.			
24. Close APL valve and occlude Y-piece.			
25. Pressurize breathing system to about 30 cm H2O with flush valve.			
26. Ensure that pressure remains stable for at least 10 seconds.			
27. Open APL and ensure that pressure decreases.			
MANUAL AND AUTOMATIC VENTILATION SYSTEMS			
Test Ventilation Systems and Unidirectional Valves			
28. Place breathing bag on Y-piece.			
29. Set ventilator parameters.			
30. Switch to Ventilator Mode.			
31. Fill bellows with and breathing bag with O_2 flush.			
32. Turn ventilator on.			
33. Set O_0 flow meter on about 5L/M.			
34. Verify ventilator function, bellows function.			
35. Verify the function of unidirectional valves.			

The OSCE by the student demonstrates foundational knowledge and correct use of the ultrasound machine in obtaining IV access: (Circle one) PASS FAIL

Does the student need to repeat this OSCE at a later date to satisfy learning requirements? (Circle one) YES NO Date to return for evaluation: _____

EXAMINER: _____ DATE: _____

APPENDIX F – Literature Matrix

Author/Title/Journal	Year of Publication	Type of Evidence/Level of Research	Summary
Al Suhaibani, M., Malki, A. A., Dosary, S. A., Barmawi, H. A., & Pogoku, M. (2014). Pre-use anesthesia machine check; certified anesthesia technician-based quality improvement audit. *Anesthesia: Essays and Research, 8*(3), 354–360. https://doi.org/10.4103/0259-1162.143142	2014	Quantitative Review	Evaluates the effectiveness of following regular inspections and running self-check recommendations by the manufacturers can contribute to avoiding any possible hazards of anesthesia machine failure during operation
American Association of Nurse Anesthetists (AANA). (2019). *Standards for nurse anesthesia practice*. https://www.aana.com/docs/default-source/practice-aana-com- web-documents-(all)/standards-for-nurse-anesthesia-practice.pdf	2019	Journal Article	Outlines the various systems within the anesthesia machine and the importance of machine checks
American Society of Anesthesiologists (ASA). (2021). *2008 ASA Recommendation for Pre-Anesthesia Checkout*. https://www.asahq.org/standards-and-guidelines/2008-asa-recommendations-for-pre-anesthesia-checkout	2021	Journal Article	Outlines the various systems within the anesthesia machine and the importance of machine checks
Butterworth, J. F., Mackey, D. C., & Wasnick, J. D. (2018). *Morgan & Mikhail's clinical*	2018	Textbook	Outlines the various systems within the anesthesia

anesthesiology (6th ed.). McGraw-Hill Education.			machine and the importance of machine checks
Chiu, M., Arab, A. A., Elliott, R., & Naik, V. N. (2012). An experiential teaching session on the anesthesia machine check improves resident performance. *Canadian Journal of Anesthesia, 59*, 280–287. https://doi.org/10.1007/s12630-011-9649-5	2012	Quantitative Review	Employs a simulation training session in order to test improvement in junior residents' ability to perform a machine check beyond the level of final-year residents who received only didactic training
Goneppanavar, U., & Prabhu, M. (2013). Anaesthesia machine: checklist, hazards, scavenging. *Indian Journal of Anaesthesia, 57*(5), 533–540. https://doi.org/10.4103/0019-5049.120151	2013	Journal Article	Outlines the various systems within the anesthesia machine and the importance of machine checks
Gurudatt, C. L. (2013). The basic anaesthesia machine. *Indian Journal of Anaesthesia, 57*(5), 438–445. https://doi.org/10.4103/0019-5049.120138	2013	Journal Article	Outlines the various systems within the anesthesia machine

Henry, Jr., D. W. (1989, December). Examination of the efficacy of education concerning a standardized anesthesia machine checkout procedure upon the machine fault detection ability of anesthetists. *Journal of the American Association of Nurse Anesthetists, 57*(6), 500-504.	1989	Journal Article	Outlines the various systems within the anesthesia machine and the importance of machine checks
Ho, C., Lin, C., & Chung, U. (2016). A short commentary about the benefits and drawbacks of OSCEs in the nursing education. *Journal of Nursing & Care, 5*(1), 315. https://doi.org/10.4172/2167-1168.1000315	2016	Journal Article	Discusses the different positives and negatives in regard to OSCE employment within nursing education
Liddle, C. (2014). The objective structured clinical examination. *Nursing Times*, 110. https://www.nursingtimes.net/roles/nurse-educators/the-objective-structured-clinical-examination-22-08-2014/	2014	Journal Article	Discusses the employment of OSCEs into nursing-related programs
March, M. G., & Crowley J. J. (1991). An evaluation of anesthesiologists' present checkout methods and validity of the FDA checklist. *Anesthesiology, 5*(75), 724-729.	1991	Journal Article	Outlines the various systems within the anesthesia machine and the importance of machine checks
Miller, R. D. (2015). *Miller's anesthesia* (8th edition). Elsevier.	2015	Textbook	Outlines the various systems within the

			anesthesia machine and the importance of machine checks
Onwudiegwu, U. (2018). OSCE: design, development, and deployment. *Journal of the West African College of Surgeons*, *8*(1), 1–22. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC6398515/	2018	Journal Article	Discusses the employment of OSCEs into nursing-related programs
Whitcher, C. (1990). Features of modern anesthesia machines. *The Official Journal of Anesthesia Patient Safety Foundation 5*(1). https://www.apsf.org/article/features-of-modern-anesthesia-machines/	1990	Journal Article/	Outlines the various systems within the anesthesia machine and the importance of machine checks
Zayyan, M. (2011). Objective structured clinical examination: The assessment of choice. *Oman Medical Journal*, *26*(4), 219–222. https://doi.org/10.5001/omj.2011.55	2011	Journal Article/	Discusses the employment of OSCEs into nursing-related programs

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